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Path Resolved Optical Sensing of Atmospheric Winds Utilizing Speckle-Turbulence Interaction and Pseudorandom Code Modulation

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13. ABSTRACT *(Maximum 200 words)*

An innovative new technique for path resolved laser doppler velocimetry is being developed that uses a continuous wave (CW) source. The use of a CW rather than the conventional pulsed laser should result in a light, compact, rugged and more reliable LDV system suitable for use in both spacecraft and aircraft. In addition, the use of multiple CW beams and complimentary pseudo random codes should allow the vector wind to be measured without scanning the beams. Potential applications are global remote sensing of atmospheric winds, wind shear and turbulence detection and primary air instrumentation. In order to obtain range resolved wind and develop the required signal to noise ratio, pseudo random, diphase modulation of the laser and a novel detection scheme has been used. Additional applications for this lidar system are path resolved optical remote sensing of chemical species (DIAL), temperature and pressure.

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FINAL REPORT

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5. NAME OF INSTITUTION: Oregon Graduate Institute of Science & Technology

6. AUTHORS OF REPORT: J. Fred Holmes

7. LIST OF MANUSCRIPTS SUBMITTED OR PUBLISHED UNDER ARO SPONSORSHIP DURING THIS REPORTING PERIOD, INCLUDING JOURNAL REFERENCES:

J. Fred Holmes and Badih J. Rask, "Optimum, optical local oscillator levels for coherent detection using photodiodes, submitted to Applied Optics, September 1993; accepted for publication.

J. Fred Holmes, John S. Peacock and Douglas C. Draper, "Optical remote sensing of surface roughness through the turbulent atmosphere," submitted to Applied Optics, August 1993; accepted for publication.

(Invited) J. Fred Holmes and Badih J. Rask, "Coherent, CW, pseudo random code modulated lidar for path resolved optical remote sensing," SPIE meeting on Atmospheric Propagation and Remote Sensing III, April 5-8, 1994, Orlando, Florida.

(Invited) J. Fred Holmes, "Optimum Local Oscillator Power Levels for Coherent Detection," International Symposium on Photoelectronic Detection and Imaging: Technology and Applications, May 17-20, 1993, Beijing China.

(Invited) J. Fred Holmes, "Statistics of Speckle Turbulence Interaction," International Meeting on Wave Propagation in Random Media, August 3-7, 1992, Seattle, Washington.

Douglas C. Draper, J. Fred Holmes, and John Peacock, "An Unwrapped Phase Distribution Model for Speckle/Turbulence, "Applied Optics, 31, 20 June 1992.

V. S. Rao Gudimetla, J. Fred Holmes, M. E. Fossey, and P. A. Pincus, "Coveriance of the received intensity of a partially coherent laser speckle pattern in the turbulent atmosphere," Applied Optics, 30, 20 March 1992.

J. Fred Holmes, "Enhancement of Backscattered Intensity for a Bistatic LIDAR Operating in Atmospheric Turbulence, "ICO Topical Meeting on Atmospheric, Volume, and Surface Scattering and Propagation, August 27-30, 1991, Florence, Italy.

Farzin Amzajerdian and J. Fred Holmes, "Time Delayed Statistics and Signal to Noise Ratio Reduction Factor for a Bistatic Coherent Lidar Operating in Atmospheric Turbulence, "Applied Optics, 30, 20 July 1991.

J. Fred Holmes, "Enhancement of Backscattered Intensity for a Bistatic LIDAR Operating in Atmospheric Turbulence", Applied Optics, 30, 20 June 1991.

8. SCIENTIFIC PERSONNEL SUPPORTED BY THIS PROJECT AND DEGREES AWARDED DURING THIS REPORTING PERIOD:

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9. REPORT OF INVENTIONS (BY TITLE ONLY):

NONE

10. PROJECT SUMMARY

An innovative new technique for path resolved laser doppler velocimetry is being developed that uses a continuous wave (CW) source. The use of a CW rather than the conventional pulsed laser should result in a light, compact, rugged and more reliable LDV system suitable for use in both spacecraft and aircraft. In addition, the use of multiple CW beams and complimentary pseudo random codes should allow the vector wind to be measured without scanning the beams. Potential applications are global remote sensing of atmospheric winds, wind shear and turbulence detection and primary air instrumentation. In order to obtain range

resolved wind and develop the required signal to noise ratio, pseudo random, diphase modulation of the laser and a novel detection scheme has been used. Additional applications for this lidar system are path resolved optical remote sensing of chemical species (DIAL), temperature and pressure.

11. HIGHLIGHTS

- First successful operation of a CW, pseudo random code (PRC) modulated, range resolved, coherent Lidar.
- First path resolved measurements of radial atmospheric winds using the Doppler shift induced by moving aerosols and using a CW, PRC modulated, coherent lidar.
- First path resolved measurements of atmospheric cross winds using speckle-turbulence interation and a CW, PRC modulated, coherent lidar.
- Verified experimentally that speckle phase decorrelation does not necessarily restrict the averaging time that can be used to recover the signal from a coherent Lidar. This result is contrary to popular opinion and could potentially have a significant impact on Coherent Lidar System design.
- Invited to organize a symposium on Optical Remote Sensing and to give an invited paper on this new Lidar System at the SPIE meeting on Atmospheric Propagation and Remote Sensing III, April 5-8, 1994, Orlando, Florida.

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